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NITROGEN-DOPED ORDERED MICRO/MESOPOROUS TEMPLATED CARBON FROM SBA-15 FOR LONG CYCLING LIFE SUPERCAPACITOR ELECTRODE

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Introduction

To further meet the demands of ideal carbon electrodes, we mainly focus on the development of carbons with uniform micro/meso pores. Additionally,considering the poor hydrophilicity of pure carbon, the incorporation of N atoms in the carbon structure can significantly change the electronic structure and surface physical and chemical properties of carbon materials, and significantly improve their conductivity, hydrophilicity and surface chemical reaction characteristics, thus further widening the application field of carbon materials.

Materials and Methods

N-doped ordered micro/mesotemplate porous carbon(NMTC) was synthesized by acetonitrile CVD using acetonitrile as nitrogen/carbon source and SBA-15 as hard template. At 600°C N_2 flow valve was switched to an aqueous acetonitrile bubbler with the flow of 100sccmfor 6 h.The capacitive performance of NOPC electrodes was investigated using a three-electrode configuration with Hg/HgO and platinum mesh as the counter electrode in 6 M KOH aqueous electrolyte.

Results and Discussion

A simple but highly efficient method using acetonitrile CVD that C and N can be impregnated in the template at one step. Scheme 1 depicts the overall procedure of the preparation of NMTC. Scheme 1 depicts the overall procedure of the preparation of NMTC.

Scheme 1. Schematic illustration of the synthesis of NMTC

TEM image of NMTC similarly shows the sidewalls of well-developed, graphitized carbon nanoscale structure, which are accompanied by the wrinkled surface.NMTC perfectly copy the well-arranged pores (Fig. 1c). In large magnification in Fig. 1d, NMTC shows and homogeneousworm like poreswith diameter of 2~4 nm.Fig.1b is an enlarged observation of the edge structure in the figure a. It is a highly ordered and highly ordered onion like graphite nanoscale structure. The onion like carbon structure can promote the double layer effect and enhance the electric field of the surface reduction.

The isotherm and the aperture distribution diagram of the sample respectively show in Fig. 2. By observing Fig. 2b, we can see that the mesoporous pore size of the sample is concentrated in range of 1.5~3nm, half as smaller than that of the original template. More mesoporesis able to help ions enter into the material, which is beneficial to transportation, suggested the better electrochemical reaction. Themicroporores is concentrated in the range of 0.7~0.9nm, and thesemicropores are favourable for storing charge and increasing capacity.

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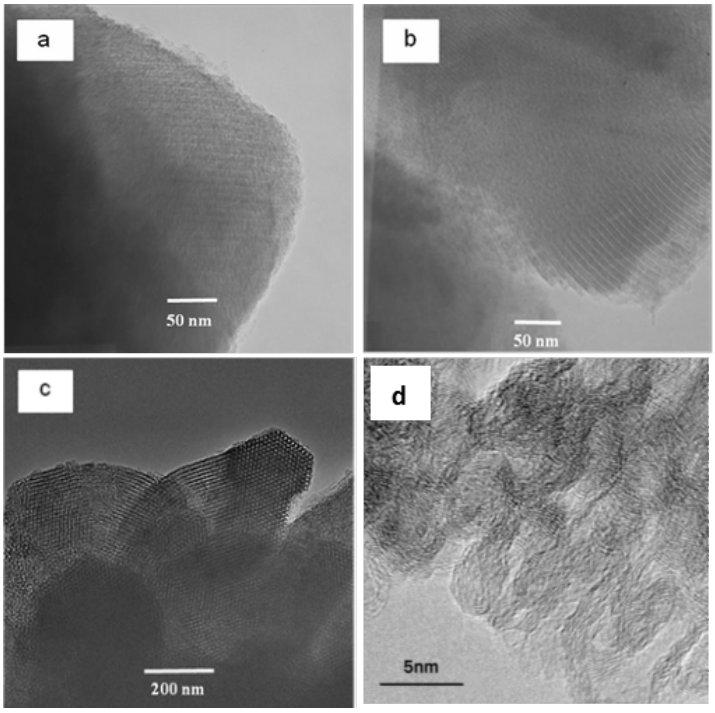

Figure 1. TEM images of SBA-15 (a), active SBA-15 (b) and NMTC (c) and (d)

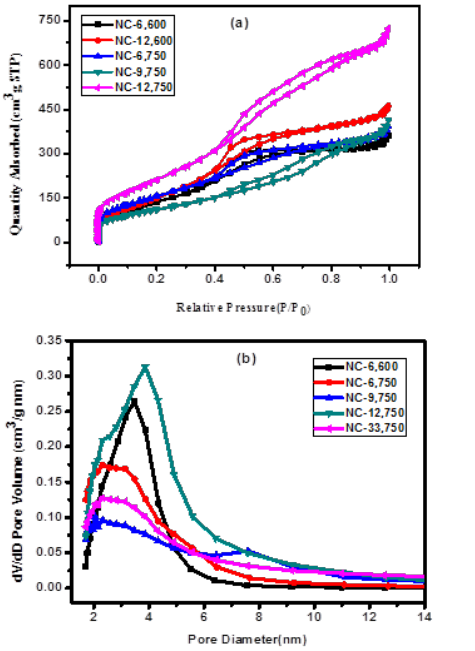

Figure 2. N_2 cryo-adsorption isotherms (a) and ordered micro/meso porous carbon of different conditions (b)

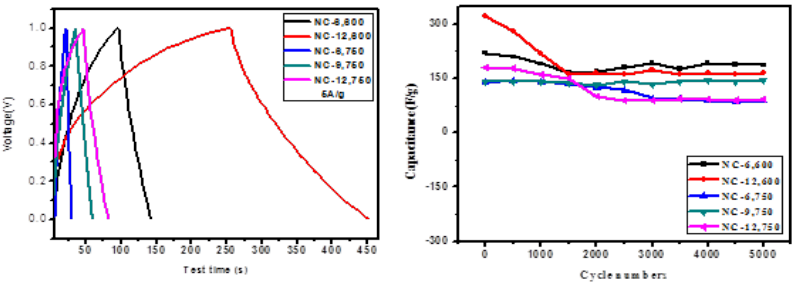

Figure 3. Charge/discharge curves and cycling lives

The current density reaches $5A \cdot g^{-1}$, the holding value of the capacitor can reach 85.2% of the initial value.When evaluating the performance of supercapacitors, cycle life is also one of the important indicators. Fig. 3 right is the 5000 charge discharge cycle test on the sample when the current density is $5A \cdot g^{-1}$, which shows that the material has a very excellent cycle stability.

Conclusions

NMTC is expected to become a high performance supercapacitor electrode material with good application prospects, and the synthetic method is promising for industry application for energy storage.

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